NASA Ames Ascent Debris Transport Analysis

Background

In 2003, the Columbia Accident Investigation Board determined that foam debris striking the wing leading-edge upon ascent was directly responsible for the loss of the Space Shuttle Columbia and its seven crew members on February 1, 2003.

As part of its Return to Flight (RTF) efforts, NASA has instituted a comprehensive study of the threat posed by debris to future launches, in order to minimize or eliminate this risk. The debris analysis team is a critical component of the RTF effort. This team uses simulation-based modeling and experimental results to quantify the damage potential of known debris sources on the launch vehicle.

The team is comprised of members of several NASA centers who are utilizing Ames Research Center's supercomputers, wind-tunnels, and ballistic range to study the aerodynamics of a wide range of debris shapes, sizes, and materials. These results are being used to develop engineering tools to accurately simulate the debris environment during ascent, which is critical to determining that the vehicle is safe to fly. These debris analysis tools will also be used for in-flight analysis of debris sighted during the vehicle's ascent trajectory.

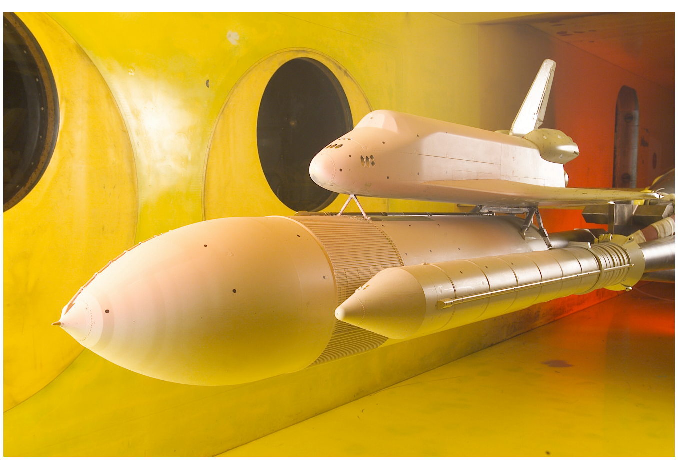

Figure 1: Photo of the 3 percent wind-tunnel model of the Space Shuttle in the NASA Ames Unitary Wind Tunnel.

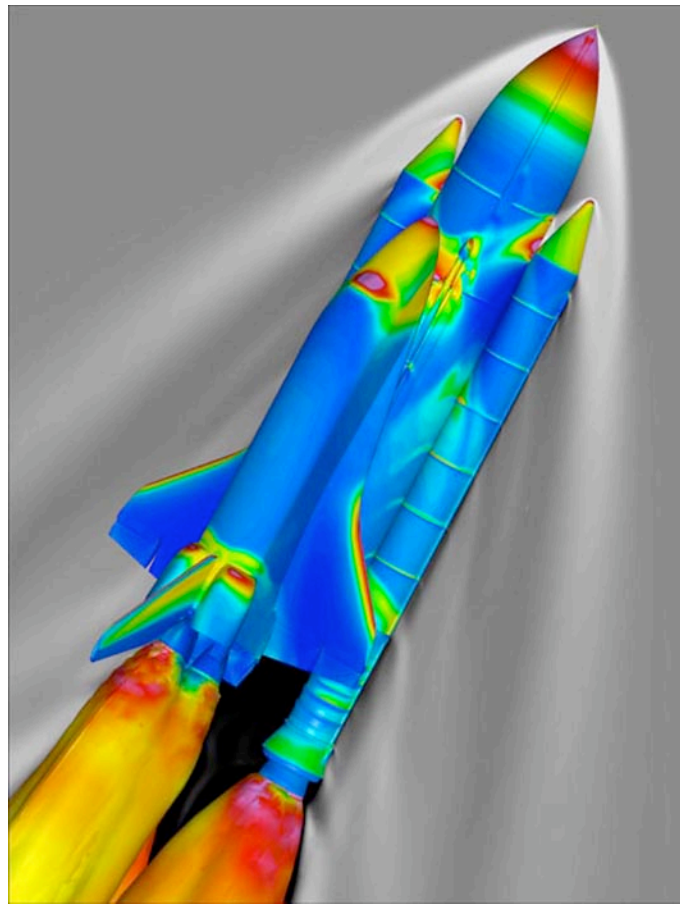

Figure 2: Flowfield around the Space Shuttle Launch Vehicle traveling at Mach 2.5 during ascent, as simulated by NASA computational fluid dynamics software on Columbia, the world’s fastest operational supercomputer.

The color represents the pressure coefficient on the surface of the vehicle, and the gray contours represent the air density.

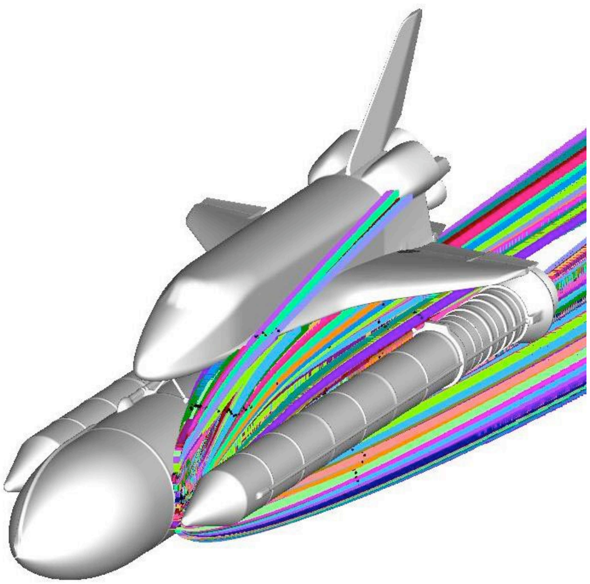

Figure 3: Plot of several trajectories depicting the path of debris shed from the External Tank.

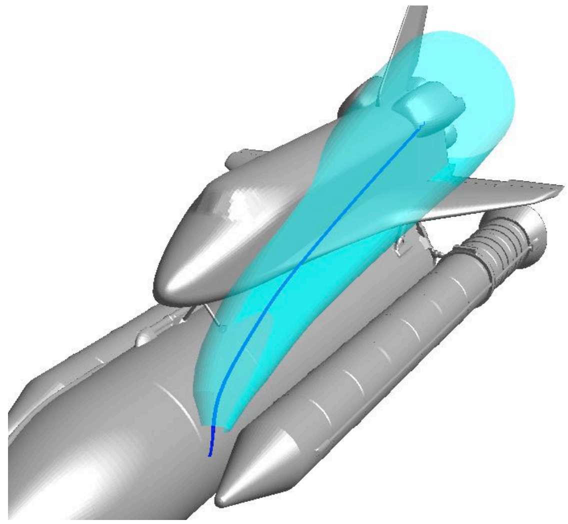

Figure 4: Debris cone used to predict all possible impact locations from a single debris piece.

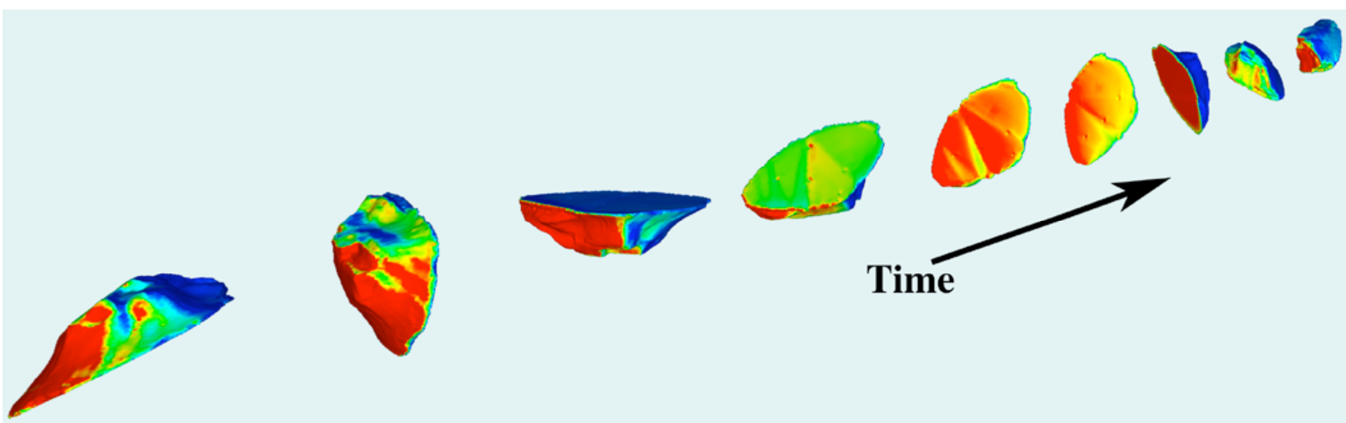

Figure 5: Time sequence of a computed six degree-of-freedom trajectory of an actual foam divot from the External Tank.

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